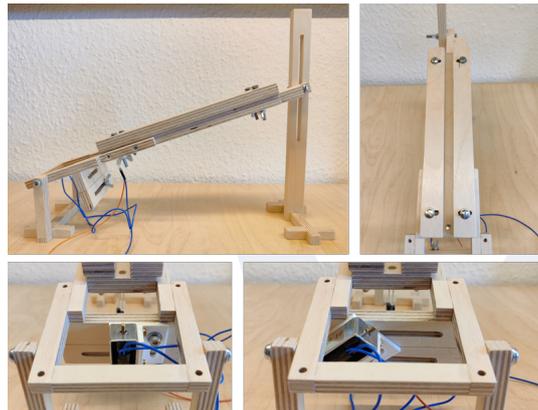


# Reinforcement Learning-Based Control of a Single-Actuator Bulk Material Sorting System



Reinforcement learning (RL) offers significant advantages over classical control approaches, particularly in systems with complex or difficult-to-model dynamics. Unlike model predictive control (MPC), which relies on an explicit system model that is often subject to inaccuracies, RL enables the implicit learning of system behavior directly from interaction data. This can result in more robust and accurate control policies, especially in nonlinear and stochastic environments. Bulk material sorting is a key technology for separating particle streams and plays an essential role in applications such as recycling (plastics, glass,

construction waste) and the development of a sustainable circular economy. Improving the efficiency and precision of sorting systems has direct environmental and economic impact.

The goal of this thesis is to develop a reinforcement learning-based control strategy for a simplified bulk material chute sorter equipped with a single actuator. The RL agent should learn an optimal control signal that maximizes sorting performance by selectively ejecting target particles.

### What to do

- Build a simulation (particle dynamics, actuator dynamics, collision modeling)
- Equip prototype system: integration of camera-based sensing and actuator control hardware (e.g., Arduino Due)
- Design the reward function based on an optimal reference trajectory for target particle ejection
- Train and deploy an RL agent: training in simulation environment, fine-tuning on physical prototype

### Requirements

Students in Computer Science, Robotics, Electrical Engineering, Mechatronics or related. You should have a good idea of probability theory and machine learning. Experience in scientific programming in Python is welcome. Strong self-motivation, endurance and mathematical problem solving skills are expected.

### Emphasis:

Theoretical Study

Software Implementation

Hardware Implementation

### We offer:

- excellent support and advice
- highend infrastructure
- contact to industry and research partners

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### Language:

German or English